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SUBJECT: NUCLEAR WASTE STORAGE/FRENCH R&D: PROGRESS AND
PROSPECTS

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Summary

[1](#)1. The influential Parliamentary Office for the Evaluation of Science and Technology Options (OPECST) recently released a comprehensive scientific report on R&D progress achieved in France in the area of high-level, long-lived radioactive waste management (HLLW). The report's final recommendations will be turned into a bill leading to a vote in Parliament in late 2006. The report asserts the scientific feasibility of the three technologies under investigation: separation and transmutation, deep geological disposal, and long-term interim storage. It concludes that all three technologies, initially perceived as "competing," are in fact "complementary" and should be included in the 2006 bill. The bill would also include a schedule for the industrial implementation of each technology (2025-2040). Finally, the authors of the report underscore that significant R&D funding will be needed to demonstrate industrial feasibility. End summary.

Background: A Very Orderly Approach

[1](#)2. In 1991, France laid out a 15-year research program, known as the "Bataille Law," to explore three options for HLLW disposal: 1) partition and transmutation of high-level nuclear waste into low-level substances; 2) geological storage (development of at least two underground laboratories in different underground areas-clay and granite); and 3) waste packaging and effects of long-term surface or subsurface storage. By 2006, the Parliament must decide which method(s) of disposal should be implemented.

[1](#)3. Earmarked money for research conducted between 1992 and 2003, mainly under the aegis of the Atomic energy Commission (CEA) and the National Waste Management Agency (ANDRA), equalled 2.2 billion euros, distributed among the three technologies under scrutiny. Regular follow up has been conducted by various committees, notably the OPECST and the National Scientific Evaluation Committee (CNE), an expert panel set up in 1994 to present to the GOF and Parliament yearly critical assessments of HLLW management programs.

[1](#)4. At the initiative of two parliamentarians, OPECST Vice-President Claude Birraux and Christian Bataille (an originator of the 1991 law), the OPECST held three days of public hearings on radioactive waste management in January and February 2005, each session corresponding to one of the research paths stipulated in the Bataille law. These hearings were preceded by private hearings with 250 scientists from 7 countries (Germany, Belgium, Finland, Sweden, Switzerland, U.S., and France). The 340-page report (in French) resulting from these meetings is available on the OPECST website: (<http://www.senat.fr/opecst/rapports.html>). The conclusions of the report will be included in the draft bill to be proposed by the GOF in early 2006 and debated in Parliament in the second half of 2006.

Separation/Transmutation -- The "Ultimate Goal"

[1](#)5. Research on separation has been conducted since 1992 at the CEA ATALANTE facility in Marcoule (Gard) and in the context of the European network ACTINET. The OPECST report notes that CEA has explored separation feasibility through aqueous processes but also investigated the possibilities offered by pyro-chemistry, an approach finding supported under the U.S. AFCI program (Advanced Fuel Cycle Initiative). It further notes that while the industrialization of advanced separation will require significant financial investment it would optimize geological storage (reduction of contents) and reduce

costs of interim storage (volume/length of time).

16. Transmutation: The scientific feasibility of transmutation has been demonstrated, according to the report, principally through experiments conducted with the fast breeder Phenix reactor. The shutdown of Phenix (2008-2009) will affect transmutation research. To achieve transmutation at an industrial scale, the OPECST report underscores the need to develop fast neutron Generation IV reactors and/or sub-critical reactors driven by accelerators (Accelerator Driven Systems, or ADS) at the horizon 2035-2040. The authors of the report emphasize in this context the need for "intense" international cooperation around the G IV program and express the view that the development of a European ADS demonstrator is "an objective worth further consideration."

Deep Geological Formation Disposal -- "Unavoidable"

17. Notwithstanding future progress in separation/transmutation, nuclear development will still generate ultimate radioactive waste. Furthermore, existing HLLW will not, for economic and technical reasons, benefit from this technology. Consequently, MP Birraux and Bataille consider that deep geological storage is "unavoidable." Bataille and other French experts favor a "reversible" repository, at least for a certain period of time (length of time remaining to be specified) to leave the door open to other modes of long-lived waste management if new technologies emerge. The report acknowledges delays in the construction of the underground research laboratory by ANDRA at Bure (Meuse), but considers that these delays are partly "compensated" by experience acquired in other research sites, notably at Mol in Belgium and Mont Terri in Switzerland. The OPECST report concludes that the argillite formation tested by ANDRA at Bure "offers favorable confinement capacities" and could be a good host for a repository. Engineering studies indicate that geological storage could be reversible for a long period of time.

Long-term Packaging and Long-term Surface Storage: "A Safe Interim Solution"

18. The report highlights significant progress made in waste packaging and long-term storage. Some research results have already been integrated into industrial processes and the volumes of high- and medium-level activity waste have been reduced by a factor of ten since 1992. The goal for long-term storage is to develop centennial interim storage (100-300 years, as compared to 50 years at present) by 2016.

OPECST Recommendations and Calendar: A Political Will

19. The authors of the report emphasize that not one technology alone will provide an answer to HLLW waste management and recommend that all three technologies be included in the 2006 law. That is to say that Parliament would incorporate in the text of the law three principles: France sets separation/transmutation as the ultimate goal for radioactive waste management and has recourse to reversible deep geologic disposal and long-term (surface/subsurface) storage.

110. Planning for the next four decades: the authors of the report propose to include in the new law the following objectives and schedule for public authorities:
-- 2016: implementation of long term storage, preferably on the site of an already existing nuclear facility;
-- 2016: authorization to build a reversible deep geologic repository;
-- 2020-25: implementation of a demonstrator reactor for transmutation;
-- 2025: implementation of geological storage;
-- 2040: implementation of industrial transmutation.

11. R&D Funding/Coordinating agency. While the report provides no detailed cost estimate, it states that significant amounts of R&D funding will be necessary to reach industrial feasibility for each of the three waste management paths defined in the law and to ensure HLLW industrial management in the long-term. To guarantee appropriate funding, the OPECST report advocates the creation of a dedicated fund, managed by the State and backed by waste producers (the French Electricity Board EDF, hospitals, etc.). The OPECST further recommends the extension of ANDRA's responsibilities to include long-term storage of all radioactive waste and non-reprocessed UOX and MOX spent fuel.

Next on the agenda

12. 2006 deadline to be met? Although behind schedule, the authors of the report consider that sufficient results are or will be available for presentation to Parliament

within the timeframe stipulated by the French legislation (i.e. late 2006). To prepare for the parliamentary vote on the law, the Research Ministry has announced a colloquium to take place in mid-2005. ANDRA will submit in June 2005 a progress report of research conducted at Bure, and the CNE will review research results during the summer of 2005. The GOF will then issue a white paper and organize a public debate (end of 2005/early 2006) and release a draft bill to be voted in Parliament at the end of 2006.

Press Reactions: Many Uncertainties/Long Way to Go

113. Several press commentators note the desire of the GOF to "conclude" the nuclear waste issue before the 2007 presidential elections even though the necessary scientific data to define waste management strategies may not be available in time for the 2006 debate. They underscore that industrial feasibility for separation/transmutation will require new types of reactors that exist only "on paper." Concerning deep underground storage, some note that Bure will hardly be operational in 2006 to provide concrete results and that the second deep underground research lab in a granite formation, also mentioned in the 1991 law (para 2), has never been built. Comment: Altogether, in terms of scientific assessment, the 2006 "deadline" is turning more and more into an intermediate benchmark. From a more political viewpoint, however, the decisions in principle recommended by the OPECST, if followed by the GOF, express a real determination to move forward France's waste management strategy on the political agenda. End comment.

Waste inventory/Figures

114. Data available end-2002 (Source: ANDRA inventory, OPECST report, Annex 1):
-- High-level long lived waste: 1639 m3; representing 0.2 percent of total volume (of radioactive waste) and 96 percent of total radioactivity; estimated annual throughput: 110 m3.
-- Long-lived mean level: 45,359 m3; 4.6 percent of total volume; 3.87 percent of total radioactivity; 600 m3.
-- Long-lived mean level: 44,559 m3; 4.5 percent of total volume; 0.01 percent of total radioactivity.
-- Short-lived mean and low: 778,322 m3; 79.6 percent of total volume; 0.07 percent of total radioactivity; annual throughput: 28,000 m3.
-- Very low: 108,219 mm3; 11.1 percent of total volume; percentage of total radioactivity: close to 0.

115. Comment: France, which produces 80 percent of its electrical power via nuclear energy, sees only a nuclear future for itself. The country has succeeded in obtaining a high degree of public acceptance for its civilian nuclear program. Part of the reason for this is the attention the government and industry already give to the back-end of the nuclear fuel cycle. The country has heavily invested in reprocessing technologies and facilities and is the world's leader in developing MOX fuel from nuclear waste. Recently, Congressman Dave Hobson (R.Oh.), Chairman of the House Energy and Water Appropriations Committee, led a delegation of members and staff to France to obtain a first-hand appraisal of the French nuclear waste system. Hobson expressed considerable interest in the French approach.
Wolff